Exercise 21.50

Q. A very long, straight wire has charge per unit length $\lambda$. At what distance $R$ from the wire is the electrified magnitude equal to $E$?

Solution. "Very long" assumes the wire is infinitely long.

If that's the case, the Gaussian surface is a cylinder where the $E$-field is perpendicular at all points.

\[ E = \frac{1}{2\pi\varepsilon_0} \frac{\lambda}{R} \]

\[ R = \frac{\lambda}{2\pi\varepsilon_0 E} \]

Let $\lambda$, charge per unit length (linear charge) be $3.80 \times 10^{-10}$ C m$^{-1}$

\[ E = 2.90 \text{ N/C} \quad \varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^2 \]

\[ R = 2.36 \text{ m} \]

\[ \left\{ \begin{array}{l}
E = 2.90 \text{ N/C} \\
\lambda = 3.80 \times 10^{-10} \text{ C m}^{-1}
\end{array} \right. \]